The climate-cryosphere-water nexus in central Asia

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The Climate-Cryosphere-Water Nexus in Central Asia

Key messages

Climate change impacts are already noticeable in Central Asia, which is expected to be one of the most vulnerable regions globally. Temperatures in Central Asia have increased steadily over the past 50 years and are projected to rise by 2.5°C–6.5°C towards the end of the 21st century depending on future emission pathways. Global warming leads to increased melting of snow and glaciers and thawing of permafrost and as such affect the overall water balance.

The mountain cryosphere is already changing and will continue to change considerably towards the end of this century, depending on emission pathways. These changes will dramatically alter the resource bases of the communities and societies depending on water availability from glaciers, snow and permafrost.

Economic development and population growth intensify impacts and risks in Central Asia. Therefore, risks related to water scarcity and changing hazards need to be assessed in the context of climatic and non-climatic drivers in order to devise appropriate adaptation solutions.

Transboundary cooperation and integrated approaches in water management are key strategies in the development of sustainable adaptation solutions in the region. Integrated Water Resources Management through the implementation of basin management principles is a key instrument for maintaining interstate dialogue and an entry point to the climate-cryosphere-water nexus. As such, cooperation on transboundary water management can be a driver for sustainable economic development and thus ultimately for cross-border peace and stability.

Excellent examples of projects and programmes relevant to development and cooperation in the region are testimony to the willingness to step up adaptation solutions that are integrative and robust, and that address unexpected changes.

Context

Why this nexus brief

The cryosphere – the frozen water component of our planet – will undergo dramatic changes in the future if anthropogenic greenhouse gas emissions continue to rise unchecked. Even if the global community achieves the 1.5–2°C aspirational goal set by the Paris Agreement, changes in the cryosphere will be massive.

In the predominantly dry climate conditions of Central Asia, the role of the cryosphere is particularly important for water resources. The main sources of water in Central Asia are the Syr Darya and Amu Darya rivers, which are mostly fed by snow melt and glacier melt from the Pamir, Hindu Kush and Tien Shan mountain ranges. Snow and glacier-fed run-off usually shows a clear seasonality with a minimum flow in the winter (snow accumulation season) and a maximum flow in the summer (melt season). Snow and glaciers substantially contribute to run-off in spring and summer, providing timely supplies to agriculture and compensating for reduced precipitation in low water years. The snowpack stores water seasonally

while glaciers store water for decades or even centuries, compensating for fluctuations in precipitation during drought periods.

The Syr Darya and Amu Darya rivers are at the heart of socio-economic development in Central Asia, supplying water for domestic and municipal uses, industrial processes, agricultural production and hydropower. Each sector is intrinsically linked, with water generating about 22% of the region's electricity supply and the rivers accounting for 75% of the irrigated agriculture in the region, with the lowlands of southern Kazakhstan, Turkmenistan, and Uzbekistan being among the mostly irrigated areas worldwide (Figure 1). The agriculture sector contributes to about 20% of the GDP of the region and accounts for up to 50% of the labour force within the countries (International Crisis Group 2014).

This nexus brief explores the interactions between changes in the cryosphere due to climate change and the consequences for water resources and hazard management in Central Asia. It analyses the status of those changes and discusses policy responses and implications for development and cooperation.

Figure 1: Water resource formation and use in Central Asia
Map produced by Zoï Environment Network, 2018

Facts & Figures

Climate warming in Central Asia expected to exceed the global average

Mean annual air temperature increases have already been observed across Central Asia. Warming trends are more pronounced in the lower elevation plains and intermontane valleys than at higher elevations. The warming across Central Asia is expected to exceed the global average, with the southernmost areas experiencing the greater shift in temperatures and the northernmost parts showing a less pronounced shift. Projections call for a 2.5°C increase in summer temperature towards the end of this century for a low emission scenario and up to 6.5°C for a high emission scenario compared with the 1951–1980 period (Reyer et al. 2017).

In a world 2°C warmer than at pre-industrial times, heat extremes will be more frequent, and local regions of Central Asia (south of 50°N from the Caspian Sea to Central China) may experience heat extremes about five times more frequently than currently (Reyer et al. 2017 and references therein).

Drier in the southwest, wetter in the northwest

Increasing precipitation has been observed in the mountain areas of the Tien Shan and the Pamir, with the trend more pronounced in the winter than in the summer. For every degree of warming, the snowline that marks the transition between snow and rain in the mountains rises by about 150 m, so mountain areas in a warmer world will experience less precipitation as snow at previous snowline elevations. At elevations well above the snowline, snow may increase, although trends and projections are inconclusive due to a lack of observations in the high mountains of Central Asia.

Future changes in precipitation exhibit a pattern where southwest regions, particularly parts of Turkmenistan, Uzbekistan and Afghanistan, may become drier whereas northwest regions, particularly parts of Kazakhstan, become wetter (Schellnuber et al. 2014). Thus, the "dry-getting-drier and wet-getting-wetter" under climate change is a reasonable approximation.

Projected loss of glacier mass by the end of the 21st century

Glaciers in Central Asia are mainly found in Kyrgyzstan (Tien Shan) and Tajikistan (Pamir) with some smaller glaciers in Kazakhstan and Uzbekistan. Glaciers play a crucial role in the availability of water resources in Central Asia throughout the year, and even in basins with a glacierised fraction of less than 5%, glacier melt water can be an important contributor to irrigation in the summer to compensate for scarce precipitation.

Observations provide clear evidence (Figure 2) that glaciers are retreating in response to global temperature increases (World Glacier Monitoring Centre, 2018). Glaciers are retreating at different rates, and the retreating trend is more pronounced in the Tien Shan range than in the Pamir. As smaller glaciers have larger relative area losses than bigger glaciers, some smaller glaciers have already completely disappeared. The enhanced melting of glaciers in Central Asia is expected throughout the 21st century, but at different rates for different elevations. Glacier mass loss by the end of the 21st century is expected to be on the order of 50% in the low emission climate scenario and up to 67% for the more pessimistic scenario when compared to the present. These changes will happen at different rates with smaller glaciers at lower altitude being more impacted, and several of them possibly disappearing by the end of the century.

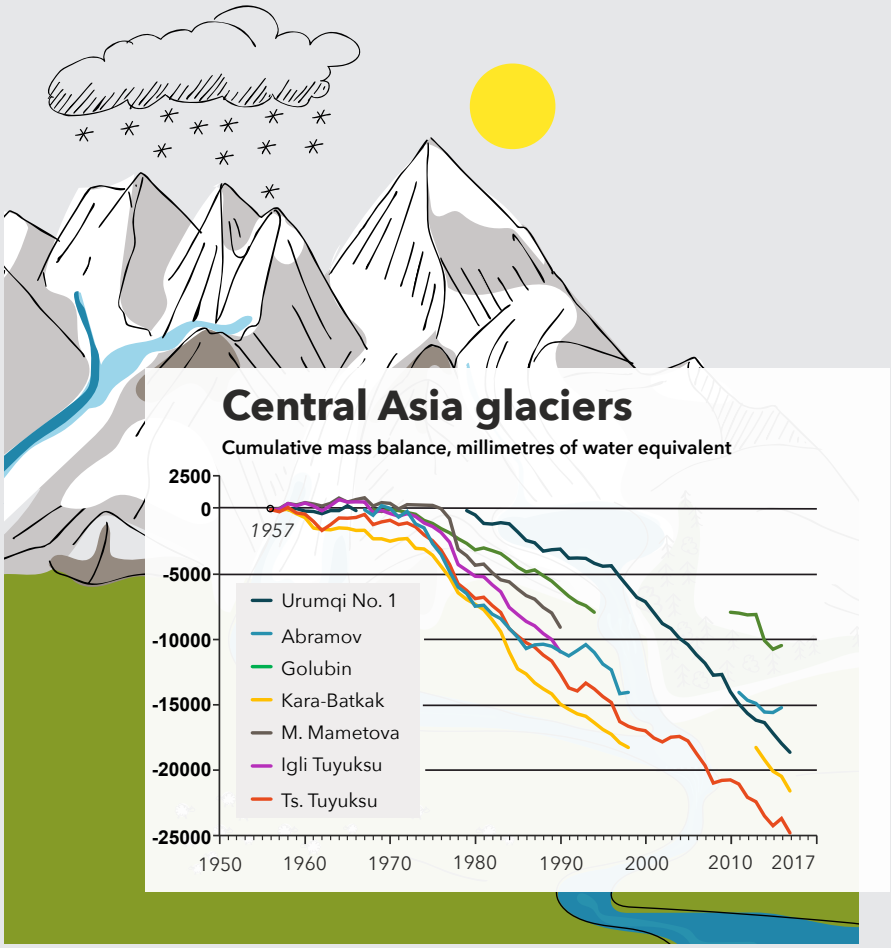
Decreasing snow cover and permafrost

Global warming is expected to decrease snow cover and to cause more precipitation to fall as rain rather than snow. An analysis based on satellite data shows a decreasing trend in snow-covered areas across all of Central Asia between 2002 and 2013. A decrease in maximum snow depth and a reduction in snow duration have also been reported. In the Tien Shan, observations of permafrost (i.e. ground frozen for at least two consecutive years) between 1977 and 2007 show an increase in permafrost temperatures between 0.3°C and 0.6°C. Modelling results estimate that the altitudinal lower boundary of permafrost distribution

Figure 2: Cumulative mass balance for glaciers in Central Asia

Source: World Glacier Monitoring Service (2018)

Long-term glaciological mass balances (differences between the year-to-year gain and loss of ice from the glacier) for glaciers in Central Asia (with more than 20 years of observations), measured between the mid-1950s and 2016. Cumulative mass balance values are given in kilograms per square metre.



has moved upward by about 150–200m and the extent of permafrost area decreased by 18% during the 20th century (Marchenko et al. 2007). Kazakhstan has a limited permafrost monitoring network, the only one in the region. Rock glaciers and permafrost in the Tien Shan and Pamir contain vast amounts of frozen water, but their conditions and melting trends remain largely unknown and under-studied. Critical infrastructure in the high mountains – strategic power lines and vital roads, major mining and tailing installations – could all be affected by changes in rock and slope stability and melting permafrost.

Studies assessing future snow and permafrost changes for Central Asia are rare, and accurate predictions for specific parts of the region are difficult to make. Nevertheless, there is agreement that snow cover is likely to decrease in the Northern Hemisphere due to temperature increases that will lead to more precipitation falling as rain, a shift of the snowline to higher elevations, a shorter duration of seasonal snow cover, especially at lower altitudes, and a widespread thaw of the frozen ground. Snow is expected to begin melting earlier in spring and may melt more rapidly. The results could include a reduction of water availability during late spring and summer (Unger-Shayesteh et al. 2013) and the triggering of sudden flooding, particularly in the rivers of northern Kazakhstan, e.g. Esil and Zhambai.

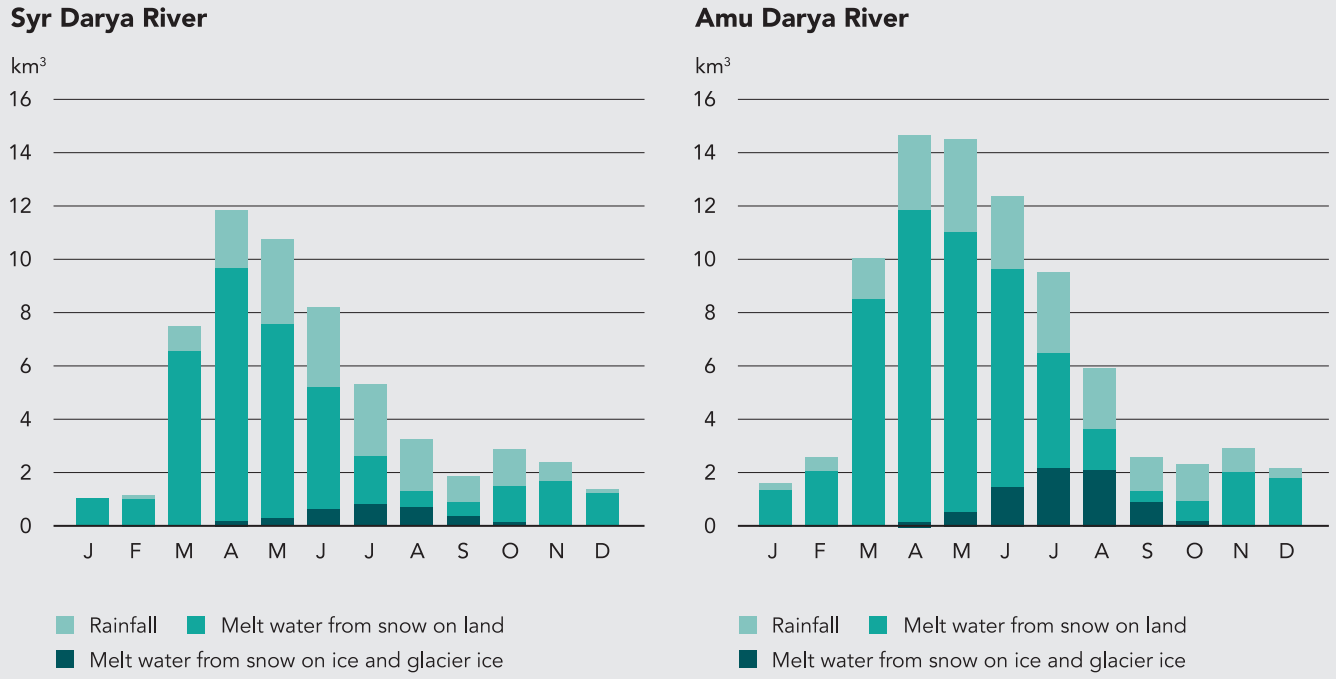
Changes in water flow

The high mountain ranges of the Tien Shan and Pamir provide about 50% of the annual stream flow to the Amu Darya and Syr Darya rivers. Changes in seasonality and the amount of fresh water from glacierised and snow-fed run-off have serious implications for water availability and thus for the future management of transboundary water resources, such as those from the Amu Darya and Syr Darya rivers.

The year-to-year amount of freshwater from the Amu Darya and Syr Darya rivers is largely influenced by seasonal climatic conditions and the amount of snow and ice in the headwater catchment of the Tien Shan and Pamir mountains. Both regions are heavily reliant on snow and ice melt sources for summer dry season (Figure 3).

River run-off responds in a complex way to climate and cryosphere changes (Figure 4). As melt rates increase, run-off will also increase until a certain point when the glacial mass is reduced to such a degree that run-off will start to decline, after passing the so-called peak water.

Figure 3: Contribution of rainfall, snow and glacier melt to river discharge in mountain areas above 2,000 meters
Source: Armstrong et al. 2019.



Up until 2030, river run-off in Central Asia is expected to vary slightly, and generally stay around normal (Reyer et al. 2017) in all climate change scenarios. In some heavily glacierised river basins, such as the SaryJaz, river run-off shows a significant short-term increase, but trends from the middle to the end of this century will depend on global greenhouse gas emissions. The point of peak water for the Aral Sea basin might come somewhere in the middle of the 21st century (Huss & Hock 2018). Towards the end of the century and depending on the climate scenario, the Aral Sea basin glacier run-off might show reductions between 10% and 40% in at least two months of the melting season (June–September) compared to the 1990–2010 period (Huss & Hock 2018). Smaller basins might reach peak water much sooner or might have already passed it.

Changes in water-related hazards

The dramatic ridged, almost vertical slopes of the Pamir and Tien Shan mountains, and their diverse geology, in combination with cryosphere changes and seismic activities can lead to the widespread occurrence of rock falls, avalanches and debris flows. The retreat of glaciers can result in the formation of lakes that are prone to devastating outburst floods that can lead to extensive damage (Figure 5). In South Asia and Central Asia, 15% of these lakes have produced floods that have damaged infrastructure, inundated farmlands, destroyed houses and claimed the lives of more than 6,000 people (Carrivick and Tweed 2016). In Kyrgyzstan, about 20% of the lakes are potentially dangerous due to unstable dams and repeated overflow (Erokhin et al. 2018). A recent flooding event in July 2015 in the Tajik Badakhshan triggered by high summer temperatures and glacier melt and snow melt destroyed about 80 residences. The mudflows also damaged about 30ha of cultivated land, destroyed key road access, and disrupted electricity supply in the area. In 2017, transboundary disasters between Afghanistan and Tajikistan damaged roads and houses. Annual losses from floods and other water-related disasters can add up to as much as 2.2% of GDP (Orlove 2015).

Figure 4: Climate change impacts on Central Asia high mountains

Produced by Zoï Environment Network, 2018.

Climate warming accelerates the melting of snow, glaciers and permafrost, affecting the overall water balance. Higher temperatures reduce the area and ice volumes of glaciers, shorten the duration of snow cover, and affect the distribution and stability of mountain areas with frozen soil and rocks. Mountain communities face growing risks to infrastructure, while downstream communities face disruptions in their water supply.

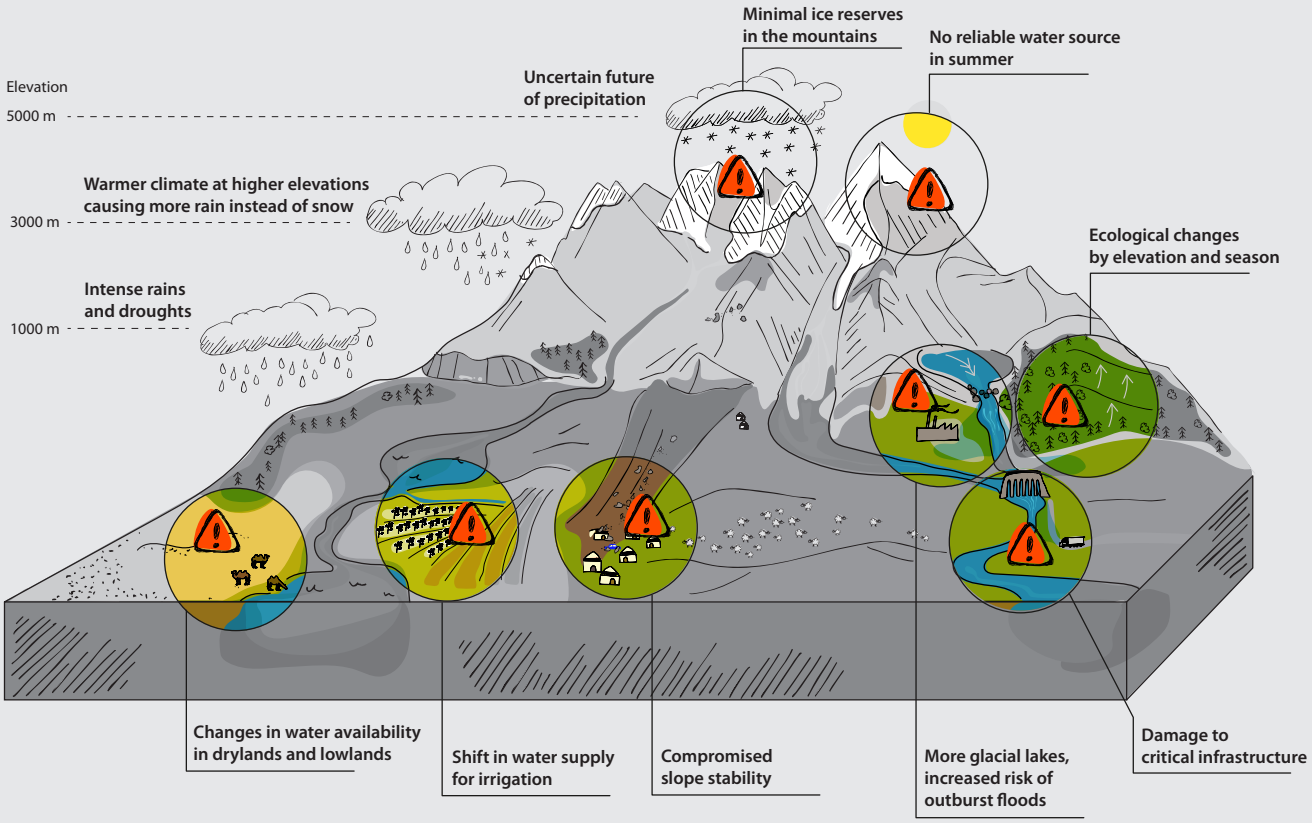
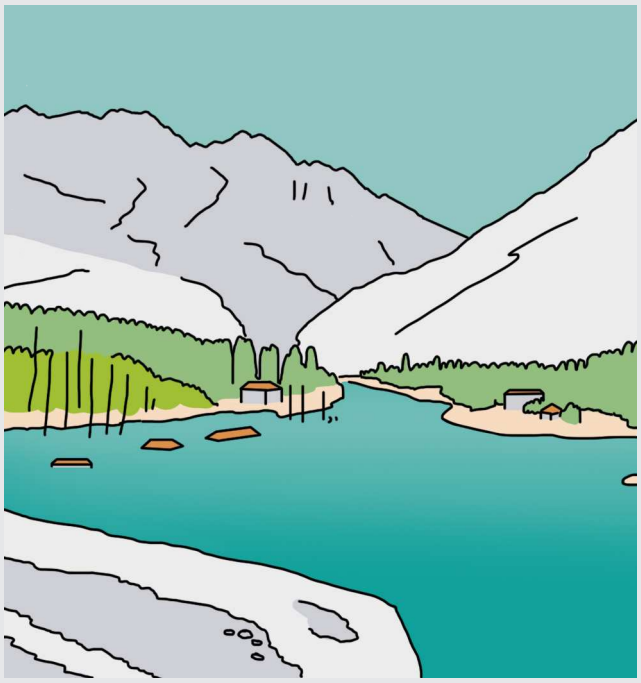


Figure 5: Barsem Lake in Tajikistan

At an elevation of about 2,500 metres above sea level, a landslide over several days in July 2015 blocked the Gunt River (a tributary of the Panj River on the border between Afghanistan and Tajikistan), leading to formation of a water body that gradually covered the villages of Barsem and Berdikov.



The thawing of permafrost may increase the region's sensitivity to associated mass movements such as rock avalanches and debris flows. Furthermore, heavy rainfall events can combine with snow and glacier melt to form floods and subsequently threaten downstream regions. These risks are likely to be compounded in the future by storm events of increased intensity (Mergili et al. 2013) and increased exposure of populations and infrastructure.

Where there is less snow and ice on the ground to dampen run-off peaks, precipitation extremes are likely to produce higher sediment transport and associated impacts downstream – deterioration of water quality, flooding, infiltration in hydropower reservoirs and damage to infrastructure and agriculture (Huss et al. 2017). This is a serious problem that has barely been assessed in Central Asia.

Water management issues and policy responses

Key challenges in a nutshell

The challenges to water resources management in Central Asia include the complex transboundary character of the region's rivers and the inherited Soviet irrigation and energy-for-water trading scheme for managing the allocation for water, energy and food. This centrally managed system transferred electricity to upstream countries during the winter and released water to downstream countries for summer irrigation. Since the collapse of the Soviet Union, Central Asia countries have been in a political and socio-economic transition, and are defining their own long-term development priorities and objectives. With upstream countries investing incrementally in their hydropower potential, the original system of allocation, primarily designed to support the irrigation regime, could not accommodate all the riparian interests. In the post-Soviet transition, the Central Asia republics have faced economic constraints that resulted in a lack of investment in infrastructure and a failure to modernize institutions.

Basin Water Organizations for the Syr Darya and Amu Darya rivers – created in the 1980s – link ministries responsible for water resources management in an effort to establish water allocation principles, set limits for water withdrawals and begin water accounting. In 1992, these organizations were merged into a broader cooperation framework, the Interstate Commission for Water Coordination, which later integrated with the International Fund for Saving the Aral Sea (IFAS). These institutions have played a critical role in maintaining a platform of dialogue and cooperation for addressing the environmental impacts of the Aral Sea crisis, but IFAS member states are now divided on the role of the platform in the coming decades. By its nature, IFAS is unable to adjust to rapidly evolving political realities and economic projects. As a result, the Kyrgyz Republic suspended its participation in 2016. Development partners have proposed and supported reforms, but no significant progress on structural changes has been achieved.

Currently all the Central Asia republics are making water sector reforms and introducing good practices, such as Integrated Water Resources Management (IWRM), at the national level. Kazakhstan, the Kyrgyz Republic, Turkmenistan and Tajikistan have adopted new water codes introducing IWRM, shifting to basin management and further modernizing information management. These long-term reforms require constant investments and institutional support from the governments. Tangible results will take time.

Since 2017, Central Asia has been experiencing a renewal of regional dialogue for cooperation on economic, trade, transport, scientific, and technical issues. The Central Asia heads of state met twice in 2018, putting water and energy at the center of discussions towards economic growth and social stability. This dialogue could open new opportunities for cooperation.

Status of climate change adaptation

The climate change impacts on glaciers, water and the environment are alarming the scientific community. The urge for action is progressively conveyed at the highest political level. At the opening of the Conference on Interaction and Confidence Building Measures in Asia, for instance, the President of Tajikistan called for international attention to melting glaciers, natural disasters and the fate of water resources under climate change, and to the role of natural resources for the sustainable development of the country.

With the exception of the Kyrgyz Republic, the Central Asian countries have signed and ratified the Paris Agreement. They regularly prepare national communications to the United Nations Framework Convention on Climate Change and have launched numerous climate projects and initiatives – from domestic carbon trading schemes and clean development projects to multi-sector strategic adaptation programmes. Climate action is gaining in importance and is increasing awareness of the climate risks and impacts on economies and livelihoods. The Central Asia Climate Change conferences organized regularly

since 2013, mainly under the Central Asia Climate Adaptation and Mitigation Program for the Aral Sea Basin (CAMP4ASB), contribute to strengthening the regional engagement on climate. The climate forum organized in April 2019 in Tashkent gathered up to 400 participants of various backgrounds from NGOs to bankers from Central Asia and beyond.

A recent review on the status of adaptation in the mountain countries of Central Asia reports that both Kyrgyzstan and Tajikistan have established adaptation priorities such as disaster risk reduction and sustainable development, and have set up coordinating structures such as the Climate Change Coordination Commission in Kyrgyzstan (Xenarios et al. 2019). The role of glaciers is also increasingly recognized as part of climate action, and several Central Asia countries are strengthening academia and research efforts. The Scientific Center for Glacier Research opened in Tajikistan in 2018 and several other institutes are in place, although capacities remain limited.

In Kyrgyzstan, sectoral climate change adaptation programmes have been established for agriculture, water resources and energy, health, forests and biodiversity (Xenarios et al. 2019). In Tajikistan, the development of water user's association (WUA) is reflected in local policies for the implementation of climate change adaptation. They have been identified as key instruments for addressing the water-energy-food nexus. In 2013 Kazakhstan launched a concept for a transition to a green economy as a tool to implement climate adaptation actions and to diversify the economy.

Key issues

Key issue 1: Expected changes in the Climate-Cryosphere-Water nexus

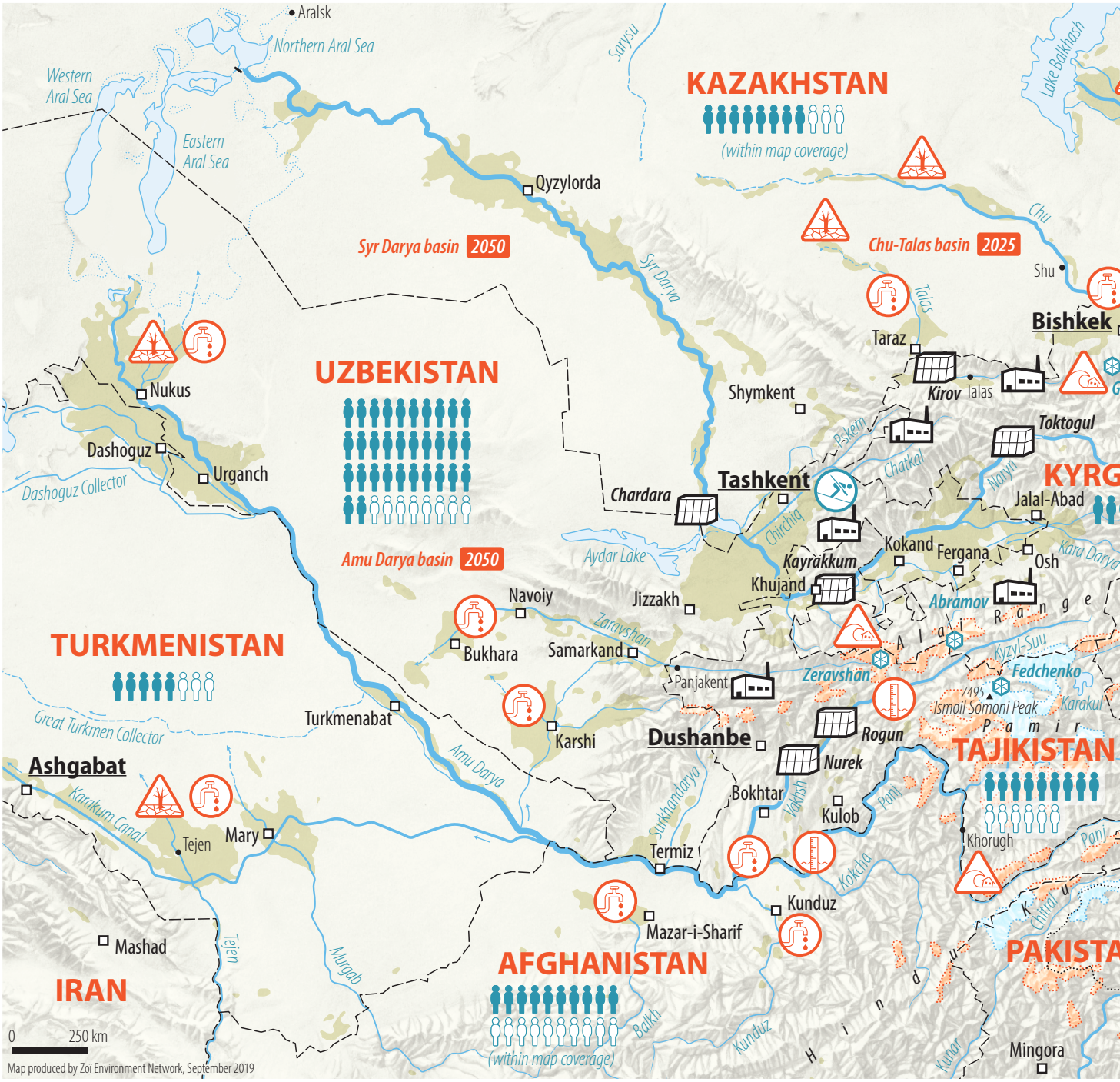
Cryosphere-related changes to water resources will be minor over the next 10–20 years compared to the massive changes expected later in the century as snow extent and duration decline and glaciers become significantly smaller or disappear. Of particular concern is the prospect of these cryosphere-related changes coming in combination with a higher frequency of droughts in some parts of Central Asia and a widespread increase of extremely hot periods. Changes in the timing and seasonality of water run-off from the mountains and changes in water quantity and quality will have major implications for future economic development in irrigated agriculture and hydropower in the region. The socio-economic consequences for a region where half of its growing population works in the agricultural sector will be serious.

Water scarcity could become a serious threat in the region, and evidence further suggests that this threat will be exacerbated by the high water demands associated with socio-economic trends, an increasing population and the conservative, slowly evolving water governance system (Figure 6). Loss of agricultural productivity due to climate change combined with inefficient irrigation practices and soaring food prices can have direct impacts on food security for large sections of the population and could even result in social unrest.

Key issue 2: Water management issues in transboundary settings

Future changes in water availability resulting from climate change call for transboundary coordination of water resources management, planning and distribution. The water-energy-agriculture-climate nexus approach has been identified as a possible way for the Central Asian states to enhance their dialogue and cross-border cooperation. The nexus approach advocates the use of integrated resources management to respond to the impacts and risks of climate change. Water, food, climate and energy are understood as interconnected sectors with specific roles in the economy, and several on-going initiatives feature the use of this concept. The Central Asia Water and Energy Program (CAWEP), established in 2009, is a multi-donor trust fund promoting water and energy security in the region. The third phase started in 2018 with the support of the Swiss State Secretariat for Economic Affairs and the European Commission, and is implemented by the World Bank. The Nexus Regional Dialogue Programme, supported by the European Union, promotes an inter-sectoral approach and prepares the ground for investments in water, energy, agriculture, and economic and environmental development planned as part of the Aral Sea Basin Program. The project is currently implemented by the Regional Environmental Center for Central Asia and a second phase is under development for 2020.

Figure 6: Impacts of climate change and demographic and socio-economic trends in Central Asia
Map produced by Zoï Environment Network, 2017.



The nexus approach helps identify and realize potential cooperation opportunities with shared benefits for sustainable growth, and should be complemented with a solid multi-stakeholder and multi-sectoral dialogue at various policy levels. A combination of top-down and bottom-up discussion initiatives could help reach key stakeholders. Persuasive political economy arguments made through hydro-diplomacy channels may deliver key messages to decision makers. On the other hand, solid and visible investments on the ground would engage other stakeholders and demonstrate the feasibility of the nexus approach. Promoting decentralization and self-governance of water management through private businesses or public-private partnerships would also support bottom-up dialogue and foster ownership

and interaction among the water users and other stakeholders. In addition, transboundary IWRM implemented on the basis of hydrological boundaries provides an ideal opportunity for inter-state dialogue on water resources management in the context of other key sectors of the economy.

Key issue 3: Improving scientific knowledge and hydrometeorological monitoring networks

The systems needed to understand the impacts of climate change and the cryosphere on water resources include remote sensing and continuous in situ monitoring of glaciers and snow cover (Unger-Shayesteh et al. 2013). The considerable uncertainties associated with the scientific evidence on climate and the cryosphere in the region are mostly attributable to inadequate monitoring and measurements – few long-term glacier measurements and spotty data on changes in run-off.

Permafrost can be important for slope stability, and as the permafrost thaws, it can increase the production of sediments that move downstream. These sediments can undermine water quality and damage infrastructure such as hydropower plants. The Global Terrestrial Network on Permafrost includes six permafrost boreholes in Central Asia (five in Kazakhstan, one in Kyrgyzstan). The north and south sides of Lake Karakul each have one, and the northern Tien Shan Mountains have four, while the Pamir and Alai ranges are unrepresented. A more robust network for monitoring permafrost – including multiple stations and long-term series of measurements complemented by field campaigns – would close some critical information gaps related to the cryosphere and climate change at high elevations. Steps are already underway to close the gaps and to build capacity among a new generation of local hydrologists, meteorologists and climate scientists (Hoelzle et al. 2017).

Relevance for Development Cooperation

The Swiss Strategic Framework for Central Asia 2017–2021 includes a regional domain of action on water, infrastructure and climate change, building on operations and long-standing experiences. The Blue Peace Central Asia (BPCA) programme is a pivotal element of this regional domain, translating the Swiss foreign policy know-how on water and peace. The programme's multi-dimensional agenda encompasses operational activities, policy dialogue and capacity-building of a new generation of water professionals.

As part of the policy work, the BPCA initiated a technical dialogue for identifying and developing the concept of shared benefits in a transboundary context. This effort led to the organization of the first high-level roundtable at the Astana Economic Forum on water as a factor in economic growth and security in Central Asia. This activity, closely coordinated with the World Bank and the European Union through the Central Asia Water and Energy Program and Nexus programmes, opens new opportunities for series of discussions based on the nexus approach.

This level of coordination is possible thanks to the establishment of the Central Asia Water Partners Coordination group co-led by the SDC and the World Bank, and involving a large number of partners. Since 2017, 10 meetings have been organized in collaboration with various organizations such as the German agency for international cooperation (GIZ), the UN Educational, Scientific and Cultural Organization (UNESCO), the UN Regional Centre for Preventive Diplomacy for Central Asia (UNRCCA) and the Asian Development Bank (ADB). Considering the increasing bilateral demands for projects with regional coverage, such coordination is critical across Central Asia.

Only the Cryospheric Climate Services for Improved Adaptation (CICADA) project remains as a full-fledged operational activity, but some small concrete activities were launched in the past few months. These include the testing phase of the automated hydrology tool established in the Chu-Talas water accounting project, the exchange visit of an Uzbek delegation to this same project, a scoping study on enhanced cooperation on natural resources management between Kyrgyzstan and Tajikistan and a scoping exercise on potential regional tracks for disaster risk reduction and climate change adaptation.

Youth activities included "From the Glaciers to the Aral Sea", a scientific expedition that produced a short movie[1] for awareness raising, and the BPCA re-launching of the Central Asia Youth for Water Network in cooperation with the German-Kazakh University and the International Secretariat for Water.

Climate resilience is garnering more interest in Central Asia with multiple activities launched at various levels. Promising developments include climate discussions in the transboundary water context of the Aral Sea and Chu-Talas basins, growing interest in the nexus approach, and acknowledging climate as a critical element in socio-economic development. However, climate actions currently rely mainly on international financing, and are not yet part of core activities. Ensuring that climate adaptation plans and strategies are integral to sustainable development in Central Asia is a next step.

The Climate Adaptation and Mitigation Program for the Aral Sea Basin, funded by the World Bank, is acknowledged as a unique climate action platform that oversees climate resilience investments and a diversity of climate knowledge services – hydrological and meteorological monitoring, climate modelling, cryosphere monitoring and exchange of knowledge. The "Transboundary cooperation on adaptation to climate change in the Chu-Talas river basins" project recognizes that climate change affects mountain hazards and water resources, and that exploitation of natural watercourses, pollution and deforestation intensify the climate effects. The project proposes adaptation approaches that carry benefits regardless of the climate and socio-economic outlooks.

1 https://youtu.be/7UEfnXxMtUE

Basin management and planning could strengthen the dialogue on transboundary water resources management in a nexus context. National water resources management projects, currently on-going in Tajikistan, the Kyrgyz Republic and Uzbekistan along the Syr Darya River, would be good vehicles.

A key entry point used by development partners for technical cooperation in the region is data and information management. Water, climate and environmental information is needed all along the way from the glaciers to the sea. SDC has been a key actor in support of collecting and processing data and building knowledge for well-informed decisions. The Kyrgyz Republic and Tajikistan are advancing towards the development of national water information systems as part of the implementation of water reform. SDC contributes to these activities in collaboration with other development partners. On the Chu-Talas River basin, SDC supports transboundary water accounting that provides real-time information on water flows to both Kazakhstan and the Kyrgyz Republic.

The improvement of meteorological monitoring and climate observation is currently underway in Kyrgyzstan, Tajikistan and Uzbekistan through such international projects as the Capacity Building and Twinning Climate Observing System CATCOS[1] and the CICADA project[2] both funded by SDC in collaboration with the University of Fribourg, Switzerland; Central Asian Water CAWA;[3] and the Contribution to High Asia Run-off from Ice and Snow CHARIS.[4] The Central Asia Hydromet Modernization project funded by the World Bank is also playing a major role in improving hydrological monitoring.

The nexus approach opens a new entry point for transboundary cooperation. Development partners are currently exploring the potential for the water-energy-climate-food approach to help achieve sustainable growth in Central Asia. The multitude of activities calls for more coordination but also for a strategic long-term vision to direct the collective efforts of the Central Asia countries. The time is also right for aggregating the results of various projects – e.g. Hydrological and Meteorological Monitoring Systems, Basin Management, Climate Smart Agriculture, Climate Resilient Investments – into larger, comprehensive programmes, and for communicating the results effectively.

1 https://www.meteoswiss.admin.ch/home/research-and-cooperation/projects.subpage.html/en/data/projects/2011/catcos.html

2 https://wgms.ch/projects/

3 https://www.cawa-project.net/

4 http://nsidc.org/charis/

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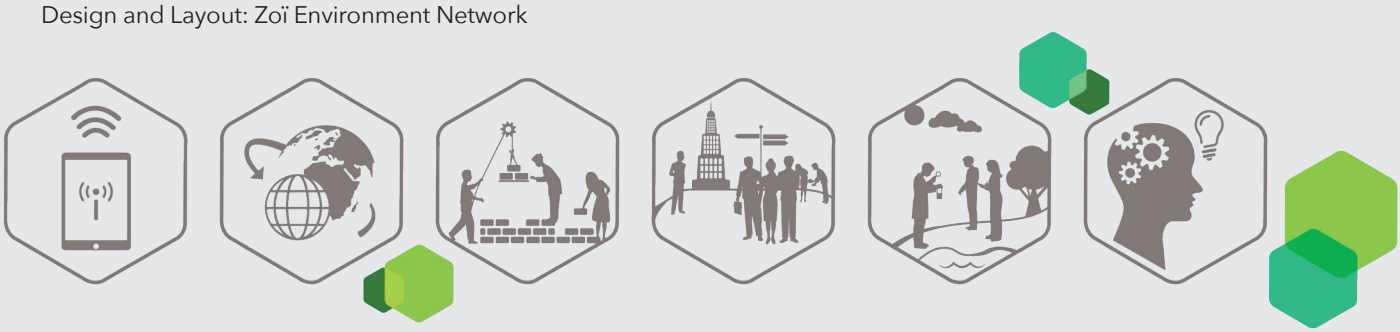

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